PHYTOTOXICOLOGY
ASSESSMENT SURVEY
OF THE
JULY 1990 FIRE
AT A USED TIRE
STORAGE DEPOT
NEAR KINGSVILLE

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PHYTOTOXICOLOGY ASSESSMENT SURVEY OF THE JULY 1990 FIRE AT A USED TIRE STORAGE DEPOT NEAR KINGSVILLE

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1 Background

On July 15, 1990 between 3:00 AM to 6:00 AM, a fire occurred at a used tire storage yard located approximately 3.5 kilometres west of Kingsville, Ontario. The yard was located near the intersection of Ontario Highway 18 and McCain Side Road; on Lot 16, Concession 1, Gosfield South Township. The lands surrounding the yard were agricultural fields and pastures.

On July 17, 1990, the Phytotoxicology Section received a request from the Ministry of the Environment Windsor District office for an investigative survey to assess possible contamination of crop plants and field soils and potential for productivity losses. It was reported that approximately 4000 tires were involved in the fire.

2 Fire Site Description

The tire storage yard consisted of a fenced enclosure 95 metres along the east-west axis and 66 metres along the north-south axis. Several buildings were located immediately east of the yard and included residences and barns. The fence was constructed of vertical wooden planks, two metres in height. The fire was confined to the northwest corner of the yard, where the majority of the tires were located. A highway trailer, which was apparently loaded with tires for shipment to a recycling facility, was consumed in the fire. A section of the fence on the west side of the yard was also consumed.

A livestock pasture was located immediately west of the yard. A field planted with soybean was approximately 40 metres north of the yard. There were several areas containing unmanaged vegetation within the yard and immediately outside.

Figure 1 illustrates the relative locations of the yard, buildings, roads and fields. This figure also identifies the locations of foliage and soil samples taken during the investigation and discussed in this report.

3 Observations and Sample Collection

The Phytotoxicology investigation was conducted on July 17, 1990. By this date, a clean-up, consisting of removal of debris and soil from the fire location, had begun. An examination of the vegetation in the immediate vicinity did not reveal any injury symptoms which could be attributed to fire emissions. Scorched vegetation was present at the west fence line where the fence was consumed. The only other indication, on vegetation, of a fire was the presence of black soot-like deposits on the foliage of grass, wild grape, hawthorn, goldenrod, as well as other species. However, these deposits were restricted to plants in the immediate vicinity of the fire and were not noted beyond 20 metres from the fence.

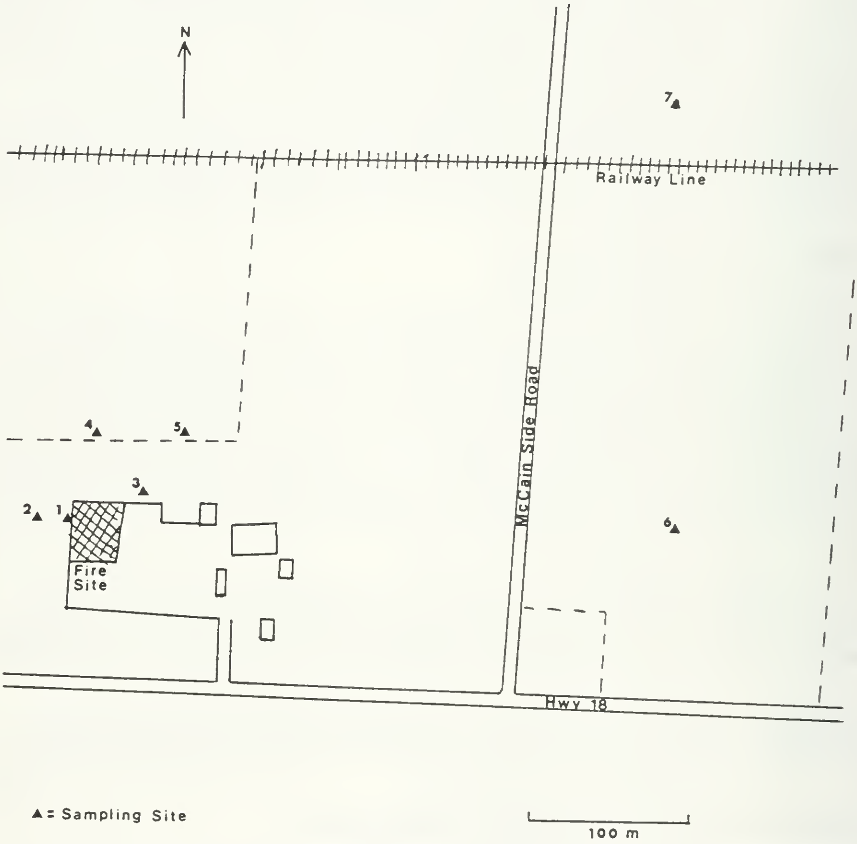
Figure 1: Sampling Locations at Kingsville Tire Fire

Because the area around the fire site consisted of agricultural fields, there was concern that contamination of crops and soil may have occurred. Sampling was conducted to determine the nature of the potential contaminants and their extent.

As previously noted, soot-like deposits were observed on vegetation near the fire site. Hawthorn foliage was collected at three locations; immediately west of the west fence (Site 1), 20 metres west of the west fence (Site 2), and 7 metres north of the north fence (Site 3). These locations are indicated on Figure 1.

Two sites for collection of soybean plants and soil were established in the field north of the yard. Both sites were five metres from the edge of the field. One was due north of the fire (Site 4) while the other was to the northeast (Site 5).

In addition to these samples collected in the immediate area of the fire, two additional sites were established for the collection of soybean plants. These were in a field approximately 500 metres east of the fire (Site 6), and in a field approximately 600 metres northeast (Site 7).

Hawthorn samples consisted of foliage removed from branches facing the fire. Soybean material consisted of whole plants above the soil level. It should be noted that the soybeans were only about 15 centimetres in height. Soil samples were taken from the top one centimetre and from the top 15 centimetres. Special protocols for collection of environmental samples destined for analysis of organic contaminants were followed. These included solvent washing of sampling equipment between samples and using special solvent-washed glass containers.

Table 1 summarizes the locations of samples (corresponding to site numbers on the figure), the nature of the sample, and the respective categories of chemical analyses.

Table 1: Sample Locations, Descriptions and Analyses Performed

Site No.	Sample Type	PAH	DIOXIN/ FURAN	INORGANIC ELEMENTS
1	Hawthorn	Yes	Yes	No
2	Hawthorn	Yes	Yes	No
3	Hawthorn	Yes	Yes	No
4	Soybean	Yes	Yes	No
4	Soil 0-1 cm	Yes	No	Yes
4	Soil 0-15 cm	Yes	No	Yes
5	Soybean	Yes	Yes	No
5	Soil 0-1 cm	Yes	No	Yes
5	Soil 0-15 cm	Yes	No	Yes
6	Soybean	Yes	No	No
7	Soybean	Yes	No	No

The selection of analyses to which selected samples were subjected was based on the experience gained with contaminants encountered as a result of a much larger tire fire near Hagersville earlier in 1990. As can be seen from this table, all samples were subjected to polycyclic aromatic hydrocarbon (PAH) analyses. Only vegetation samples close to the fire were subjected to dioxin and furan analyses. Inorganic element analyses were performed only on soil samples.

4 Chemical Analysis Results

All of the above described samples were submitted to various sections of Laboratory Services Branch for analysis. The following summarizes the results of these analyses.

4.1 Polycyclic Aromatic Hydrocarbons (PAH)

All samples, (hawthorn, soybean and soil) were subjected to an analysis of the PAH's listed in Table 2. The limits of detection, in micrograms per gram (ug/g) dry weight, are also indicated.

Table 2: Detection Limits for PAH Compounds Analyzed

Polycyclic Aromatic Hydrocarbon	Detection Limit (ug/g)
Dibenzo(a,h)anthracene	0.04
Benzo(g,h,i)perylene	0.04
Naphthalene	0.04
Acenaphthylene	0.05
Acenaphthene	0.04
Fluorene	0.04
Phenanthrene	0.07
Anthracene	0.01
Fluoranthene	0.02
Pyrene	0.06
Benzo(a)anthracene	0.02
Chrysene	0.02
Benzo(k)fluoranthene	0.02
Benzo(b)fluorene	0.06
Benzo(a)pyrene	0.04
Indeno(1,2,3-cd)pyrene	0.04

Without exception, the concentrations of the listed PAH's were below their respective detection limits in all samples.

4.2 Dioxins and Furans

As indicated above, only hawthorn foliage and whole soybean plants collected in the immediate vicinity of the fire, were subjected to analysis of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans. Table 3 lists these samples, their location by site number, and the concentrations detected in the samples. Detection limits vary from sample to sample in these analyses. Concentrations with the 'less than' symbols (<) represent the detection limits for each of the dioxin and furan congener groups for the respective samples.

There were no furans detected in any of the samples. Dioxin congeners were either not detected or had very low concentrations in the hawthorn samples. Dioxins were detected in the soybean samples and the concentrations of the more highly chlorinated congeners were much higher than the lesser chlorinated congeners.

Table 3: Dioxin and Furan Concentrations

Polychlorinated Dibenzo-p-dioxin Concentrations
(parts per trillion dry weight)

Site No.	Sample Type	T4CDD	P5CDD	H6CDD	H7CDD	O8CDD
1	Hawthorn	< 2	< 2	< 2	6	68
2	Hawthorn	< 1	< 2	< 4	4.2	17
3	Hawthorn	< 2	< 4	< 3	< 5	< 30
4	Soybean	< 1	7.2	28	150	2500
5	Soybean	1.1	11	56	170	3000

Polychlorinated Dibenzofuran Concentrations
(parts per trillion dry weight)

Site No.	Sample Type	T4CDF	P5CDF	H6CDF	H7CDF	O8CDF
1	Hawthorn	< 3	< 2	< 2	< 4	< 2
2	Hawthorn	< 2	< 1	< 3	< 2	< 2
3	Hawthorn	< 2	< 4	< 3	< 5	< 10
4	Soybean	< 1	< 4	< 2	< 5	< 5
5	Soybean	< 1	< 1	< 1	1	< 1

T4CDD = Tetrachloro Dibenzo-p-dioxin
P5CDD = Pentachloro Dibenzo-p-dioxin
H6CDD = Hexachloro Dibenzo-p-dioxin
H7CDD = Heptachloro Dibenzo-p-dioxin
O8CDD = Octochloro Dibenzo-p-dioxin

T4CDF = Tetrachloro Dibenzofuran
P5CDF = Pentachloro Dibenzofuran
H6CDF = Hexachloro Dibenzofuran
H7CDF = Heptachloro Dibenzofuran
O8CDF = Octochloro Dibenzofuran

4.3 Inorganic Elements

Only soil samples were submitted for chemical analysis of inorganic elements. These samples were taken at the sites of soybean samples in the field immediately north of the fire. Soybean plants were not collected because they were covered with soil particles splashed up by rain. This would contaminate the plant material and make it impossible difficult to interpret the data. Table 4 contains the results of these analyses.

Table 4 also contains the Phytotoxicology Upper Limit of Normal (ULN) Guidelines for rural soil samples. These concentrations are based on collections and analyses of soil samples collected in rural areas not influenced by point sources.

Consequently, the data represents the upper limits of concentrations which may be encountered in rural environments. ULN Guidelines are more fully explained in the attached Appendix.

The concentrations of inorganic elements in soil samples collected near the fire site do not exceed the respective ULN guideline concentrations, where such concentrations are available. Also, there is no indication of higher inorganic element concentrations in the 0-1 cm samples overlying the 0-15 cm samples. Such might be expected if these elements were emitted during the fire and deposited in significant quantities in the adjacent agricultural fields.

Table 4: Concentrations of Inorganic Elements in Soil (ug/g dry weight)

Site No.	Sample Type	Cu	Ni	Pb	Zn	Mn	Cd	Co	Cr	Mo	Na	Sr	V
4	Soil 0-1 cm	22	19	17	53	240	.46	14	20	3.6	56	17	40
4	Soil 0-15 cm	29	21	18	65	250	.55	15	23	3.8	80	20	49
5	Soil 0-1 cm	20	15	15	55	160	.49	12	18	2.0	46	17	38
5	Soil 0-15 cm	59	19	17	76	180	.47	14	26	2.8	49	20	47
ULN	Soil 0-5 cm	60	60	150	500	700	3	25	50	na	na	na	70

ULN = Upper Limit of Normal, see attached Appendix
na = ULN not available

5 Discussion

As was mentioned previously, the sampling scheme and choice of contaminants for chemical analysis were based on experience gained at the Hagersville tire fire. The fire at Hagersville was considerably larger in terms of the number of tires involved and the duration of the fire. As yet unpublished data on PAH concentrations in spruce foliage indicate a high degree of contamination by PAH compounds at a site approximately 100 metres from the edge of the fire site. Concentrations of the same PAH compounds as analyzed in Hagersville investigation are in the thousands of parts per billion. Various PAH compounds could be detected, albeit at low concentrations, in spruce foliage several kilometres from the fire.

These observations are totally contradictory to those at the Kingsville fire. Here there were absolutely no PAH compounds detected in any foliage samples. Detection limits ranged from .01 to .07 ppm (10 to 70 ppb). This failure to detect PAH compounds applies to hawthorn foliage that had visible soot-like deposits, as well as to the soybean and soil samples.

The results of the dioxin and furan analyses indicate that there were virtually no furans detected in any of the vegetation samples. Only the *hepta* (H7) and *octo* (O8) dioxins were detected in the hawthorn foliage, but at very low concentrations. It can be noted that the highest hawthorn dioxin concentrations were in the sample collected nearest the fire, however, since the concentrations were close to the detection limits, it is not valid to draw conclusions about distance trends.

On the other hand, dioxins were clearly present in the two soybean samples taken in the nearby field. All congeners were detected. The samples also show a clear gradient of increasing concentrations from the *tetra* (T4) to the *octo* (O8) chlorinated congeners. Limited dioxin and furan data obtained by the Phytotoxicology Section from other sample sites across the province suggests that, in soil and vegetation, the concentrations tend to increase with degree of chlorination, and that this gradient occurs in the absence of potential pollution sources.

Such a trend was also present in vegetation samples at Hagersville. However, Hagersville samples also contained significant furan concentrations.

These observations cast some doubt on the source of the dioxins in the soybean samples. If they are of fire origin, then one must question the negative results for the hawthorn samples, which were much closer to the fire. There is the possibility that the dioxin component of the fire plume 'looped' over the nearest receptors and was deposited at greater distances only.

It is also possible that the dioxins in the soybean were of soil particle origin (rain splash). The soil may be contaminated by impurities in herbicides and pesticides applied to this agricultural field in the past.

Another explanation may be related to the morphological properties of the two plant species. Soybean is quite pubescent and may be more capable of trapping dioxin containing particles emitted by the fire.

6 Conclusions

This investigation failed to detect Polycyclic Aromatic Hydrocarbons in soil and vegetation samples collected in the vicinity of the tire fire. Dioxins were only detected in soybean plants and not in hawthorn foliage that was much closer to the fire.

The lack of furans and the presence of higher chlorinated dioxin congeners lends doubts regarding the source of these dioxins. By comparison, the Hagersville fire emitted both dioxins and furans.

There was also no detectable contamination of soil in a nearby agricultural field by inorganic elements.

Based on the information generated by chemical analyses of environmental samples, there is no conclusive evidence of contamination of soil or vegetation by the tire fire.

Appendix

Derivation and Significance of the MOE Phytotoxicology "Upper Limits of Normal" Contaminant Guidelines.

The MOE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a point source of pollution. Urban ULN guidelines are based on samples collected from developed urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (ref: Ontario Ministry of the Environment 1983, *Phytotoxicology Field Investigation Manual*). Chemical analyses were conducted by the MOE Laboratory Services Branch.

The ULN is the arithmetic mean, plus three standard deviations of the mean, of the suitable background data. This represents 99% of the sample population. This means that for every 100 samples which have not been exposed to a point source of pollution, 99 will fall within the ULN.

The ULNs do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULNs are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULNs are not known to be toxic.

ULNs are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULNs. The MOE Phytotoxicology ULNs are constantly being reviewed as the background environmental data base is expanded. This will result in more ULNs being established and may amend existing ULNs.